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Bronchial Asthma in Infants and Children—Its Diagnosis and Treatment

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BRONCHIAL asthma in early and late childhood as in adult life³ and old age⁴ is practically always due to food or inhalant allergy or both, rarely to drug and bacterial allergy. This conclusion is based on the demonstrated causes in 156 infants and young children up to the age of five years and in 255 older children up to the age of 15 years observed between 1940 and 1946, in whom good or excellent results have been obtained. These results compare with those in similar age groups published in 1937.¹⁰

In this series, asthma occurred twice as frequently in males as in females (Table 1), whereas in later age groups the males and females were equal in number. There was a familial predisposition to asthma in 50 per cent of the cases with a lesser tendency to other manifestations of allergy. As noted in Table 2, moderate or moderately severe symptoms of asthma were most common. The frequency of other manifestations of allergy is also shown, perennial nasal allergy occurring in 56 per cent.

TABLE 1.—*Number of Patients, Males and Females, and Family History of Possible Allergy*

	Age of Child		Totals
	0-5 Years	5-15 Years	
Number of Patients.....	156	255	411
Males	102	174	276
Females	54	81	135
Family History:			
Bronchial Asthma.....	84	125	209
Nasal Allergy.....	68	67	135
Headaches	14	28	42
Eczema	9	16	25
Hives	8	10	18
Gastrointestinal Symptoms.....	8	20	28

DETERMINATION OF ALLERGIC CAUSES OF BRONCHIAL ASTHMA

I. HISTORY

The history is more important than skin testing. This is recorded in all our patients according to a previously published plan.^{5,8}

A. Evidence Indicating Food Allergy

1. Bronchial asthma due to food allergy may begin at any time of life, even in old age.

TABLE 2.—*Duration and Degree of Bronchial Asthma and Occurrence of Other Manifestations of Allergy*

Duration of Asthma (in years):	Age of Child		Totals
	0-5 Years (156 Cases)	5-15 Years (255 Cases)	
0- 1	73	35	108
1- 2	52	29	81
2- 5	31	77	108
5-10	98	98
10-15	16	16
Degree of Asthma:			
Mild	20	15	35
Moderate	43	79	122
Severe	76	130	206
Very Severe.....	17	31	48
Other Manifestations:			
Nasal Allergy			
(a) Perennial	92	165	257
(b) Spring to Winter..	8	25	33
Hives	21	22	43
Eczema	71	84	155
Headaches	3	13	16
Gastrointestinal			
Symptoms	16	41	57

TABLE 3.—Frequency of Asthmatic Attacks, "Colds" Before Attacks, Perennial Bronchial Asthma and Dietary and Environmental Histories Suggestive of Allergy

	Age of Child		Totals
	0-5 Years (156 Cases)	5-15 Years (255 Cases)	
Regular Recurring Attacks	57	90	147
Irregular Attacks.....	92	109	201
"Colds" Before Attacks.....	78	84	162
Perennial Symptoms.....	83	176	259
Positive Dietary History.....	85	117	202
Positive Environmental History	17	106	123

Food allergy as the major or sole cause of bronchial asthma in infants and children is usually indicated by the following classical history. The asthma usually arises in the first three years, especially from the 16th to the 26th month. At times it is preceded by infantile eczema. The attacks usually recur regularly every two to eight weeks (See Table 3). Coryza, nasal congestion and sneezing due to nasal allergy rather than to an infectious cold, may precede the bronchial asthma by four to 24 hours, or may arise and continue through the attack. The asthma is characterized by varying degrees of dyspnea, wheezing and coughing, or coughing and wheezing may predominate. Fever often occurs, varying from 100° F. to 104° F., for one to four days. In the authors' opinion, the fever usually is due to food allergy,^{10,11} although respiratory infection may be the major or secondary cause. Anorexia, nausea and, at times, vomiting occur during the attacks. The asthma may disappear rapidly, or wheezing, tightness in the chest and coughing may gradually decline in from three to ten days.

These attacks can be explained by the gradual accumulation of reacting bodies in the cells of the lungs. When they exceed the reacting threshold, they unite with the causative food allergens in the pulmonary and other body cells. With the exhaustion of these reacting bodies, the symptoms disappear, even though causative foods continue to be eaten. At regular intervals thereafter the reacting bodies redevelop and the attack recurs.

Between attacks, relief may be complete or partial. In a year or more this refractoriness may decrease with resultant intervening, even daily coughing, wheezing, tightness in the chest and dyspnea especially with exercise, after retiring and often from 2 to 5 a.m.

The attacks may only occur or be exaggerated from early fall to late spring, especially from December to April (See Table 3), and may be absent or decreased in severity and frequency during the summer months due to seasonal influences on food allergy⁶. When this summer effect is absent, perennial symptoms arise from food allergy.

It is also important to realize that most recurrent head "colds" (See Table 3), with or without bronchial symptoms, which recur at quite regular intervals every two to eight weeks are due to nasal and

bronchial allergy, especially to foods, rather than to respiratory infection. Slight wheezing and tightness in the chest may be present, but definite bronchial asthma usually is absent. Fever, if present, also may be due to food allergy, though a secondary respiratory infection may be responsible. These "colds" usually recur from early fall to late spring due to the intensification of food allergy during these seasons, invaliding or keeping children in bed or out of school one-fourth to one-half of the time.

2. A dietary history of dislikes or disagreements for specific foods also suggests food allergy (See Table 3). Such a history is not indicative of clinical food allergy in all cases and often is negative when food allergy is responsible (compare Tables 3 and 4). Questions should be specific; for example: "Do you drink milk?" "Do you eat eggs?" "If not, why?" Allergy to foods, such as cottonseed oil or shortening, wheat or even pepper, which are combined with other foods is difficult to discover in a history, and must be recognized rarely through skin testing and usually through diet trial.

3. The authors have obtained limited help from detailed diet diaries, which usually are time-consuming to patient and doctor and rarely are accurate.

B. Evidence in the History of Inhalant Allergy

Inhalant in contrast to food allergy infrequently causes cyclic recurrent attacks with intervening refractoriness and freedom from symptoms. Occasionally encountered inhalants will produce irregularly recurring attacks. Usually the continued inspiration of inhalants causes persistent asthma, the degree of which may vary with the amount in the air.

Since pollens are in the air of most of California throughout the year except during the rainy season, perennial asthma of varying degrees may be due to pollen allergy alone. Asthma from dusts, animal emanations and other miscellaneous inhalants encountered indoors may occur or be exaggerated in the fall to spring months.

A detailed environmental history may or may not reveal possible causes. Inhalants in the home, from trees and other vegetations out of doors, and in working environments, especially in barns, animal yards and gardens, must be listed and suspected. Mold allergy must be considered in damp areas or home, especially where mildew and molds readily grow.²

When inhalant and food allergies are operative in the same patient, perennial asthma is usual. The symptoms may vary in degree according to the amount of the allergenic inhalants, especially pollens, which are inspired, the degree of allergy present, the allergenic foods ingested and the seasonal and geographic effects on food allergy.

II. SKIN TESTING

Skin testing should be done by the scratch tests with all important ingested foods and inhaled allergens. Intradermal tests with foods are not done by the authors because of the many reactions which are nonspecific or indicative of past or potential

allergy and because of the rare deaths^{8,10} reported from such tests. When suspected inhalant allergy is not revealed by the scratch test or empiric desensitization with suspected inhalants is not helpful, then intradermal testing with 1-1000 dilutions of inhalants which have elicited no reaction in the scratch test may be done, especially in older children. The frequency of reactions in these infants and children (See Table 4) approximates that in adults³ and old age.⁴

The fallibility of the skin test in demonstrating clinical food allergy must be remembered. Many of the small reactions to inhalants and especially to foods are nonspecific or indicate a past or potential allergy. This is true to a lesser extent of the larger reactions. Negative reactions, moreover, usually occur to most foods causing chronic or cumulative symptoms, as already noted, and to about 10 to 15 per cent of inhalants.

The clinical importance of positive reactions can be determined only by the reproduction of the symptoms with inhalation or ingestion of specific allergens by the symptom-free patient. The cumulative effect of food allergens especially may allow a food to be eaten for several days before symptoms arise. Moreover, temporary desensitization or refractori-

ness due to the seasonal allergenic effects may allow foods to be eaten for weeks before symptoms recur.

III. ELIMINATION DIET FOR THE STUDY AND CONTROL OF FOOD ALLERGY

Since the skin test often fails to reveal clinical food allergy, one of the authors for over 20 years has used standardized elimination diets⁸ for the study of possible food allergy. Because of the frequency of allergy in bronchial asthma to one of or all the cereal grains in addition to milk, egg, fish, nuts and less often other foods that are excluded from these diets, the cereal-free elimination diet is utilized. This diet, modified for infants, substitutes soy for animal milks and adds the proper vitamins, starches, meats, vegetables and fruits as age increases. A modified diet for children up to the age of three years is published,⁸ and the cereal-free elimination diet for adults is available for older children.⁸

The advantages of the standardized elimination diets reside in the list of specific foods, the detailed menus with specific amounts of foods, the protection of weight and nutrition, the tested recipes for bakery products, the use of vitamins and calcium which harmonize with the diets, the ease with which the diets

TABLE 4.—Number and Degree of Skin Reactions to the Scratch Test

Pollens:	Age of Child		Totals (411 Cases)	Per Cent of All Patients
	0-5 Years (156 Cases)	5-15 Years (255 Cases)		
(a) Grass:				
0 - 1 +	35	79	114	46%
1 - 4 +	23	48	71	
4 + up	0	5	5	
(b) Fall:				
0 - 1 +	20	57	77	26%
1 - 4 +	9	20	29	
4 + up	0	0	0	
(c) Trees:				
0 - 1 +	21	57	78	25%
1 - 4 +	4	21	25	
4 + up	0	0	0	
(d) Cultivated Flowers:				
0 - 1 +	23	37	60	18.5%
1 - 4 +	2	14	16	
4 + up	0	0	0	
Animal Emanations:				
0 - 1 +	33	88	121	38%
1 - 4 +	8	24	32	
4 + up	1	4	5	
Miscellaneous Inhalants:				
0 - 1 +	21	61	82	25%
1 - 4 +	6	12	18	
4 + up	1	1	2	
House Dust:				
0 - 1 +	13	56	69	20%
1 - 4 +	2	11	13	
4 + up	1	1	2	
Fungi:				
0 - 1 +	3	6	9	3%
1 - 4 +	2	3	5	
4 + up				
(Tests were not routine)				
Foods:				
0 - 1 +	50	60	110	40%
1 - 4 +	24	23	47	
4 + up	3	4	7	
No Reactions.....	38	46	84	20%

can be ordered in the hospitals and with which the office patient can be instructed in their use.

The elimination diets when accurately prepared insure proper weight, nutrition and growth. This is important since formerly eaten foods remain in the body for several days and possibly for a few weeks, necessitating the use of the diet for more than a few days.

The original diet should be continued until the period of relief is at least twice as long as preceding periods of relief. If prolonged daily symptoms have been present and relief arises in a few days to two weeks, continuing for an equal period, it is probable that the causative foods have been excluded from the diet. If attacks of asthma have recurred every two to six weeks, then relief must continue for four to twelve weeks, or longer, before this conclusion is justified. When chronic asthma has been present, the resultant cellular changes may not disappear until the shock tissues have been free from the allergenic foods for several weeks—and at times certain irreversible changes remain.

If persistent asthma is not relieved in one to three weeks or if recurrent attacks continue with the use of the diet, changes in the elimination diet as discussed elsewhere⁸ may be indicated along with the study of possible inhalant, drug and (rarely) bacterial allergy.

When relief is assured, individual foods may be added, one every three to seven days, as advised in other publications⁸. Foods tolerated during the summer may cause symptoms in the fall to spring months due to the exaggeration of food allergy in those months.⁶

IV. STUDY AND CONTROL OF INHALANT ALLERGY

When the history indicates pollen allergy, even with negative skin reactions, desensitization is required. Our experience indicates the advisability of treatment with most of the pollens present in the air when the asthma occurs. Such multiple antigens contain from 5 to 30 pollens for each pollen season. Treatment is started with very weak dilutions, varying from 1-5,000,000 to 1-500,000,000,000 or even weaker dilutions for infants. The initial and at times desensitizing dose may be determined by serial intradermal titrations as advised recently by Rinkel. The doses are gradually increased, as tolerated, to successively stronger dilutions. In general the maximum dose during the first year should be as small as will give relief, rarely being greater than the 1-5,000,000 in infants and the 1-50,000 or 1-5,000 in young children. In adolescence the 1-500 or the 1-50 dilution may be tolerated and beneficial, especially in the winter and pre-seasonal periods. If symptoms recur during the season, the dose must be reduced at times to the very weak dilutions, which often are necessary for the control of atopic dermatitis.⁹

Pollen filters in the bedrooms and living rooms are helpful when pollen allergy is severe.

Fungus allergy must be studied in the patients suspected of inhalant allergy, especially if molds

are found in damp rooms, closets or basements. Desensitization with antigens containing the prevalent fungi in the indoor or outdoor air or with autogenous fungus antigens may be necessary. Allergy to dust, animal emanations and miscellaneous inhalant allergens requires strict environmental control and desensitization with those allergens which cannot be eliminated from the inspired air. The dilutions and doses are similar to those advised for pollen therapy.

V. THE STUDY AND CONTROL OF BACTERIAL ALLERGY

Bacterial allergy as a major cause of bronchial asthma was not demonstrated in any case in this series. Tonsils and adenoids often had been removed without relief. In the authors' opinion, the so-called head "colds" which occurred for one or more days before the attacks of bronchial asthma in 162 of the cases as shown in Table 3 were due to the same food and, less often, inhalant allergens which were responsible for the subsequent or accompanying bronchial asthma or allergic bronchitis. As one of us has reported¹¹ for several years, the fever even up to 105° F. during these attacks also may be due to food allergy, though an associated respiratory infection must be ruled out. This is in contrast to Cooke's opinion¹ that such colds and fever favor bacterial allergy as a cause of so-called infective asthma. The leukocytosis in varying degrees and frequencies in these patients, as shown in Table 5, was usually due to food and/or inhalant allergies, since the control of these allergies resulted in normal values in practically all cases. Against bacterial allergy, moreover, was the occurrence of head colds or bronchitis actually due to infection without the development of bronchial asthma when the causative food and/or inhalant allergies were controlled. Mothers often state that "for the first time a 'cold' has occurred without any asthma."

Though bacterial allergy did not cause the bronchial asthma and the less frequent nasal allergy in these cases, a low resistance to respiratory infection seemed apparent in some patients. When this was probable, stock respiratory vaccine was administered, starting with a dose of 40,000 to 400,000 bacteria according to age, with a gradual subsequent increase, the injections being given every five to ten days until a dose of 20,000,000 to 120,000,000 was given as tolerated and according to age. The repetition of this final dose every seven to ten days throughout the fall, winter and spring months, or

TABLE 5.—*Leukocytosis in 411 Infants and Children With Bronchial Asthma Due to Food and/or Inhalant and (Very Rarely) to Bacterial Allergy*

Leukocytosis	Age of Child	
	0-5 Years (156 Cases)	5-15 Years (255 Cases)
10-12,000	27	30
12-15,000	20	26
15-20,000	14	9
20-40,000	2	0
	63 (40%)	65 (25.5%)

even throughout the year, raises resistance in a specific or nonspecific manner and may also be of nonspecific benefit to the atopic allergy.

VI. PHYSICAL EXAMINATION AND ROUTINE LABORATORY STUDIES

Careful physical examination, all indicated laboratory studies on blood, urine and sputum and roentgen examination of the chest and, when indicated, of the sinuses must be used to rule out other recognized causes of dyspnea, wheezing and cough and reveal any other disease.¹⁰

THE CAUSES OF BRONCHIAL ASTHMA IN 411 INFANTS AND CHILDREN UP TO THE AGE OF 15 YEARS WITH GOOD OR EXCELLENT RESULTS FROM TREATMENT

These results were obtained by the control of the various allergies as listed in Table 6. By excellent results we mean complete control or only occasional wheezing, especially if a slight break in the diet or undue exposure to causative inhalants occurs. By good results we mean relief from all symptoms except for moderate wheezing or slight coughing one or two times during the night or with exertion due to lapses in cooperation or failure to discover or control all allergenic causes. In all patients severe symptoms may occur when allergenic foods are reintroduced into the diet with or opposed to the physician's orders. Food allergy alone was responsible in 143 cases, pollen allergy alone in 24 cases and other inhalants alone in 26 cases. Food allergy with or without inhalant allergy required control in 339 cases and inhalant allergies of all types with or without food allergy in 270 cases. Fungus allergy associated with other inhalant allergies was important in six cases. Evidence of minor bacterial allergy was obtained in five cases. A similar importance of the above causes has been demonstrated in the authors' patients in adult life and also in old age.^{3,4}

Cooperation in these cases lasted from six months to six years.

INFANTS AND CHILDREN UNDER THE AGE OF 15 YEARS WHO WERE UNRELIEVED OF BRONCHIAL ASTHMA

From 1940 to 1946, 61 additional patients were seen. As shown in Table 7, 31 did not report after the first visit, 17 reported only during the first month,

and ten from six to twelve months. Cooperation was satisfactory in only seven of these 61 patients.

TREATMENT OF MODERATE BRONCHIAL ASTHMA

The plan of treatment used by the writers to obtain good or excellent results in 411 infants and children is summarized under specific and symptomatic control.

A. Specific Control

1. When inhalant or drug allergies are not the sole obvious causes, food allergy is studied immediately with our standardized cereal-free elimination diet.⁸

2. When inhalant allergies of any type are indicated by history or skin testing, environmental control and, if necessary, desensitization with suspected allergens which the patient continues to inhale are necessary.

3. Rare bacterial and drug allergies need study as already discussed.

B. Symptomatic Control

This is necessary until the specific control reduces or eliminates the symptoms.

1. Ephedrine in doses of 4.0 mg. to 25.0 mg., according to age, every four hours often relieves or eliminates moderate symptoms. Phenobarbital in doses of 2.5 mg. to 8.0 mg. or corresponding doses of other barbitals may be given with the ephedrine to reduce resultant nervousness.

2. Aminophyllin by mouth in doses of 30 mg. to 90 mg., according to age, every three to twelve

TABLE 7.—Unrelieved Bronchial Asthma in 61 Patients, Aged 0-15 Years, Seen from 1940 to 1946	
Number of Patients.....	61
Good Cooperation.....	7
Poor Cooperation.....	54
Time of Treatment:	
None.....	31
1- 4 Weeks.....	17
1- 3 Months.....	1
3- 6 Months.....	2
6-12 Months.....	10

TABLE 6.—Causes of Bronchial Asthma in 411 Infants and Children as Determined By Good Results from Specific Control

	Age of Child		Total (411 Cases)	Per Cent of 411 Patients
	0-5 Years (156 Cases)	5-15 Years (255 Cases)		
Food With or Without Other Allergies.....	138	201	339	82%
Food Allergy Alone.....	78	65	143	35%
Inhalant and Other Allergies.....	90	180	270	66%
Inhalant Allergies (Other than Pollen).....	11	15	26	6%
Pollen and Other Allergies.....	79	165	244	59%
Pollen Allergy Alone.....	4	20	24	6%
Animal Emanation and Other Allergies.....	10	16	26	6%
Miscellaneous Inhalant and Other Allergies.....	8	14	22	5%
House Dust and Other Allergies.....	15	49	64	16%
Fungus and Other Allergies.....	2	4	6	1%
Bacterial and Other Allergies.....	2	3	5	1%
Excellent Results.....	83	146	229	53%
Good Results.....	73	109	182	47%

hours may relieve moderate asthma. Enteric coated tablets delay its action.

3. Potassium or sodium iodide in doses of one to ten drops in water three times a day often helps patients with persistent asthma. If swelling of submaxillary glands, blocking of the nose, headache or later a skin eruption occurs from allergy to iodine, it should be stopped. Later, smaller doses may be tolerated with benefit.

4. Epinephrine 1-100 by inhalation usually helps moderate asthma.

5. Epinephrine 1-1000 subcutaneously in doses of 0.1 cc. to 0.5 cc., according to age, every two hours if necessary, usually relieves symptoms which do not respond to the foregoing measures.

6. Intramuscular epinephrine 1-500 in gelatine in doses of 0.1 cc. to 1.0 cc., according to age and weight, every six to twelve hours may yield prolonged relief. Peanut, cottonseed or even corn oil should only be injected when absence of allergy to these oils is assured.

7. When severe asthma is not relieved by the foregoing therapy, aminophyllin in doses of 0.09 gm. to 0.2 gm., according to age, injected by vein slowly over a three-minute period is indicated in children over the age of six years. Intramuscular injections in doses of 0.09 gm. to 0.2 gm., according to age, may be given every six to twelve hours.

8. No morphine, codein, demerol, paraldehyde, or barbitals other than the already indicated doses of phenobarbital should be given to any case of bronchial asthma. Depression of respiration or cerebration with resultant anoxemia and at times death justify this rule.¹⁰

9. Other measures used in chronic cases as discussed elsewhere⁸ may be advisable.

THE TREATMENT OF INTRACTABLE BRONCHIAL ASTHMA

The authors' treatment of intractable bronchial asthma is summarized under specific and symptomatic control.

The patients require hospitalization or a similar room and care at home. Immediate consideration of the probable major food and inhalant causes is imperative.

A. Specific Control

1. Unless inhalant allergy is the obvious sole cause, the cereal-free elimination diet is immediately ordered to study possible food allergy. If vomiting is present, intravenous glucose in saline or water as indicated by electrolyte balance is necessary. When nausea decreases, liquid or soft foods and later ordinarily cooked foods in the diet are given.

2. Inhalant allergy needs immediate study with strict environmental control. If pollen allergy is possible, a pollen window filter may be advisable in the pollen seasons. Desensitization, although it may be indicated, should be postponed until relief occurs.

3. Rare drug and less frequent bacterial allergies need study as already discussed.

B. Symptomatic Control

1. Epinephrine 1-1000 subcutaneously in doses of 0.1 cc. to 0.6 cc., according to reaction and age, every one to four hours may give relief.

2. If epinephrine does not help, aminophyllin by vein in doses of 0.06 to 0.3 gm., according to weight and age, given over a period of from three to five minutes every eight to twelve hours is advisable. This may also be given in 5 per cent glucose with or without saline.

3. With dehydration, especially with nausea or vomiting, intravenous 5 per cent glucose in saline or water according to sodium chloride and water requirements is necessary.

4. If asthma is extreme, especially if cyanosis or possible cardiac weakness is present, oxygen by tent or under pressure with BLB mask should be ordered. In the authors' practice, oxygen-helium has not been necessary in children. As a life-saving measure oxygen or oxygen-helium with Barach's positive pressure helmet may be of value.

5. The use of morphine, codein, barbitals, demoral or paraldehyde is contraindicated, especially in intractable bronchial asthma, for already discussed reasons.

6. As asthma decreases, the measures previously advised for the control of moderate symptoms become increasingly effective.

DISCUSSION

These good and excellent results in patients who gave proper cooperation demonstrate that food or inhalant allergies or both are responsible for bronchial asthma in infants and children as they are in mid-life and old age.⁴ Food allergy was a sole cause in 50 per cent of infants and young children and it was associated with inhalant allergy in another 38 per cent of the cases. It was the sole cause in 26 per cent of the older group, being associated with inhalant allergy in another 53 per cent. Inhalant allergy of all types was a major or secondary cause in 58 per cent of the young group and 71 per cent of the older group of children. Thus food allergy is more important than inhalant allergy and is a more important sole cause in the younger children than in the older children. This demonstrated importance of food allergy is in marked contrast to the recent opinion of Hill.¹² Inhalant allergy, on the contrary, increases in the older children.

The usual inability to determine cumulative or chronic food allergy by skin testing is emphasized by this study. Skin reactions by the scratch test were obtained in approximately 40 per cent of all patients in whom food allergy was a cause of asthma. However, in practically all these patients some allergenic foods were not indicated by positive reactions and one or more positive reactions were not indicative of active clinical allergy. Moreover, no reactions to foods or inhalants occurred in 27 per cent of the young group or in 23 per cent of the older group, in most of whom food allergy was the sole cause.

Our frequent recognition of food allergy has been accomplished with the free use of the authors' cereal-free elimination diet⁸ or its modifications. The advantages of trial diet of this type already have been noted. The usual failure of test-negative diets to demonstrate clinical food allergy has been discussed.

The classical history of bronchial allergy in children due to food allergy has been described for the first time in the literature. The regularity of the attacks due to refractoriness which arises to allergenic foods after an attack and the exaggeration or recurrence of bronchial asthma in the fall to spring months due to activation or exaggeration of food allergy during these seasons have been noted.

It is important to realize that most "head and bronchial colds" that recur regularly every two to eight weeks, especially from early fall to late spring, are also due to allergy, especially to foods, rather than to respiratory infection.

As discussed in this paper, the determination of inhalant allergy depends on history, skin testing and results of treatment. Most of the patients sensitive to inhalants gave positive reactions, although all positive reactions were not indicative of actual clinical allergy. As shown in Table 6, allergy to all types of inhalants is a slightly less important cause than is food allergy, and it increases in frequency in the older children.

Of these inhalants, pollens are much more frequent causes than are animal emanations, dust, fungi or miscellaneous inhalants. With Efron dust extracts during the last year, larger and more frequent reactions have been obtained, all of which are not of clinical significance. Pollen allergy, however, as a sole cause is rare compared with allergy to foods in these age groups.

In these infants and children bacterial allergy was not a major cause of bronchial asthma in any patient. No recovery depended on tonsillectomy and no nasal or sinal operations were performed. As already stated, the fever up to 104° F. which often occurs during severe attacks of asthma, usually is due to food allergy,¹¹ although associated respiratory infection, including pneumonitis, must always be suspected. The occurrence of infectious colds without the development of bronchial asthma when its causes are adequately controlled speaks against infection or bacterial allergy as a cause of the symptoms and fever.

Our plan of treatment thus immediately considers food and inhalant allergy as indicated by the history and skin testing. It also depends on the use of adrenalin hypodermically and on aminophyllin by vein in older children for the control of severe symptoms. For the control of moderate symptoms, ephedrine by mouth, epinephrine by inhalation, aminophyllin by mouth or by rectum and potassium iodide by mouth are usually effective. Morphine, other opium derivatives, demerol, paraldehyde and barbitals for relief of asthma are contraindicated in all cases for previously discussed reasons.

CASE REPORT

A boy 26 months old was first observed in October, 1944, because of bronchial asthma recurring since March every four to six weeks. Each attack had been initiated by exaggerated nasal symptoms lasting for one day, followed by wheezing, difficult breathing, coughing and fever up to 101° F. rectally for two days.

Since infancy, "head colds" had recurred every six to eight weeks, characterized by nasal congestion, blocking of the nose and sneezing, especially in the morning, and with a moderate fever. Mild nasal congestion and sneezing had continued between these colds. For the last eight months asthma had followed the colds.

Eczema involving the face had occurred between the ages of three months and nine months, and occasional hives had been present.

The dietary history revealed no dislikes or idiosyncrasies for any foods; drug and environmental histories were negative for allergy; family history revealed asthma in the maternal grandfather.

The physical examination showed a pale, slightly edematous nasal mucosa, slightly enlarged tonsils and diffuse evidences of bronchial asthma throughout both lungs. A roentgenogram of the chest showed no abnormality.

Results of urine analysis were normal. Blood examination showed hemoglobin 82 per cent, with leukocytes numbering 15,850 and erythrocytes 4,700,000. Differential: polymorphonuclear 52 per cent (nonsegmented 3 per cent), lymphocytes 34 per cent, large monocytes 1 per cent, eosinophiles 11 per cent, basophiles 1 per cent.

Skin testing with all important inhalants showed 1-plus reactions to chicken feathers, dog hair, glue, coastal sage, western ragweed and spearscale pollens. There were no reactions to skin tests with all important foods.

Treatment and Results: Because of the frequency with which food allergy causes regularly recurring head and bronchial "colds," with or without bronchial asthma, the authors' cereal-free elimination diet was prescribed. Calcium carbonate one-quarter teaspoonful in food two times a day and five drops of drisdol daily were ordered. In two weeks all nasal and bronchial symptoms had disappeared. Since Mull-Soy was refused, more prescribed meat was ordered to maintain protein requirements. Soy-potato bakery products made with the authors' recipes were eaten. The original diet was maintained for two months, after which additional vegetables and fruits gradually were added.

During the last one and a half years, corn, rye, oats, wheat, fish and recently egg and milk gradually have been added. No asthma has recurred, except on two occasions after the addition of rice—the first time in five days and the second time in nine days after its daily ingestion.

Two typical head colds have recurred with no resultant asthma. The child now sleeps quietly, has a good disposition, and gained eight pounds in one and a half years.

Discussion: The control of the recurrent head colds since infancy and of the more recent associated bronchial asthma with the elimination diet, demonstrates food allergy as the cause.

The addition of rice has caused asthma twice. If allergy to egg and milk originally were present, their long elimination from the diet could have raised tolerance so that they now produce no symptoms. If asthma recurs, especially in the fall, winter and spring months when food allergy so often is activated, the original cereal-free elimination diet will be resumed. Milk especially will be suspected.

No desensitization with inhalants and no injections of non-specific agents or vaccines were given to yield this result.

CASE REPORT

A boy 3 years of age was first observed in May, 1944, because of bronchial asthma. Wheezing had developed six months previously on a ranch where there were many trees, animals and alfalfa. For one day preceding the beginning of the wheezing, a "head cold" characterized by coryza and sneezing had been present. Since then four similar increasingly severe attacks had occurred. Four of the five attacks had developed on the ranch and one in the patient's city home.

No other manifestations of allergy had occurred. No food dislikes or disagreements were elicited. The drug history revealed vomiting from a sulfa drug. Environmental history showed the presence of Bermuda grass in the lawn. No trees and no animals were around the city home. There was a family history of bronchial asthma in the maternal uncle, hay fever in the paternal grandmother and hives in the mother.

Upon physical examination, slightly enlarged tonsils were noted. No indications of asthma were ascertained since the patient was in a symptom-free period. A roentgenogram of the chest was normal, as were results of blood and urine analyses.

Skin testing by the scratch method with all important food and inhalant allergens showed 3-plus reactions to rice, oats, peas and navy beans, 2-plus to wheat, oats, tomatoes, string-beans, peaches and prunes, and 1-plus to milk, eggs, potatoes, oranges and grapefruit. A 5-plus reaction to mugwort pollen was noted, 2-plus to alfalfa, cocklebur, spearscale and chrysanthemum pollens, 2-plus to kapok and cottonseed and 1-plus to tobacco and cat hair.

Treatment and Results: Because of the suspicion of pollen allergy, especially to alfalfa, as indicated by history and skin testing, desensitization with a multiple antigen containing all the important spring and summer and fall pollens in the areas in which the patient lived was started with the 1-50,000,000 dilution. The doses were increased so that by October the 1-5,000 dilution was tolerated. In the last one and a half years the 1-500 and later the 1-50 dilutions have been given at weekly intervals.

Although reactions were not obtained to animal emanations, other than cat hair, or to feed dusts, other than alfalfa, another antigen containing allergens of all the feeds and of all the animals on the ranch was administered along with the pollen antigen eight months after the first visit. An initial dose of 1-50,000,000 gradually was increased up to the 1-50 dilution at the end of one year.

Because of the positive skin reactions, especially to cereal grains, milk, egg and legumes, and the necessity of considering food allergy in all patients suffering from chronic recurrent bronchial asthma of the perennial type, the authors' cereal-free elimination diet minus peas and stringbeans was ordered at the first visit.

Severe asthma developed three days after treatment was started, and a mild attack occurred about two months later when the patient was at the ranch. His appetite increased in two weeks. In November the patient had a bad cold with no resultant asthma. Even though he has been in contact with alfalfa and has been on the ranch, no symptoms have occurred except for mild wheezing on one occasion when he was playing in the hay at the end of the first four months of treatment.

During the second year all foods gradually were added to the diet with no difficulty. In the fall of the third year a cough with fever up to 104° F. recurred on three occasions. Since reactivation of food allergy was suspected, the cereal-free elimination diet again was ordered. Since then all symptoms have been absent and a general diet gradually has been resumed.

Discussion: The results obtained with the antigens made of pollens, feed dusts and animal emanations indicate inhalant allergy as the major cause. Had larger reactions been obtained, treatment would have been started with a 1-5,000,000,000 or even a 1-500,000,000,000 dilution.

Despite the many positive skin reactions to various foods, the patient's history was not suggestive of food allergy. However, the possibility of food allergy was studied with the authors' cereal-free elimination diet minus peas and stringbeans. It is difficult to determine whether this diet aided in obtaining the good results in the first few months. The reappearance of the cough and fever in the fall and winter of 1946 does suggest temporary activation of food allergy, as often occurs in those months.

SUMMARY

1. Bronchial asthma in the authors' patients from birth to the age of 15 years is due principally to food allergy and, to a lesser degree, to inhalant allergy. Drug and bacterial allergies are rarely causative.

2. The classical history of bronchial asthma in infancy to childhood due to food allergy is described.

3. Recurrent head and/or bronchial colds with or without mild asthma every four to eight weeks, especially from September to May, are often due to chronic food allergy rather than to respiratory infections.

4. The fallibility of the skin test, especially in determining chronic food allergy, is stressed.

5. The use of standardized elimination diets is advised and the special value of the cereal-free diet is noted.

6. The use of environmental control and desensitization with inhalant allergens that cannot be avoided are available for the control of inhalant allergy.

7. The great rarity of bacterial allergy as the cause of bronchial allergy is stressed.

8. The specific and symptomatic treatment of chronic and intractable bronchial asthma is outlined.

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